

9 Apr 84

CHAPTER 7

PAVEMENT JOINTS

7-1. Joint types and usages. Joints are required in rigid pavements to permit expansion and contraction of concrete due to temperature and moisture changes, to relieve warping and curling stresses which result from temperature and moisture gradients within the slab, to minimize uncontrolled cracking caused by frost action, and as a construction expedient to separate the areas of concrete placed at different times. There are three general types of joints used in rigid pavements: (a) contraction, (b) construction, and (c) expansion. Guidance relative to the requirements for these joints is given in the following subparagraphs.

a. Contraction joints. Contraction joints are provided to control contraction cracking from temperature changes and from the initial shrinkage of the concrete. The minimum depth of the groove for contraction joints generally should be one-sixth of the pavement thickness, but not less than the maximum nominal size of the aggregate used. However, where this depth has been found to be insufficient to produce the desired cracking at the groove, the depth of the groove should be increased to one-fourth of the pavement thickness. The size of the groove should conform to the dimensions shown on Standard Mobilization Drawing No. XEC-006.

(1) For transverse contraction joints in nonreinforced rigid pavements, sufficient load transfer can be developed from the aggregate interlock along the fractured face of the joint so that no other provision for load transfer is required in Classes D and E pavements. For reinforced rigid pavements, the longer slab lengths will result in larger openings at the transverse contraction joints and for all such pavements the transverse contraction joints should be doweled. Dowels are also required for Class B nonreinforced pavements.

(2) Longitudinal contraction joints are required along the centerline of nonreinforced rigid pavement lanes having a width equal to or greater than the maximum spacing indicated in paragraph 7-3, for transverse contraction joints for various pavement thicknesses. Where such longitudinal joints are required, tie bars should be used to prevent cumulative opening of the joint and excessive separation of the adjacent lanes. The tie bars should be No. 5 deformed steel bars, 30 inches in length. Spacing of the tie bars should be 30 inches, center to center.

(3) For reinforced rigid pavements where two traffic lanes are placed as a single paving lane, a longitudinal dummy groove joint should be provided at the centerline of the paving lane to control cracking during concrete placement. In these joints, the reinforcing steel is carried through the joint, and tie bars are not required.

9 Apr 84

(4) Longitudinal contraction joints at the centerline of reinforced rigid pavements are required only when the width of the pavement exceeds the allowable length of slab, L , for the percentage of steel reinforcement being used. When such joints are required, the steel reinforcement should be broken at the joint, and tie bars similar to those described above should be used.

b. Construction joints. Construction joints are provided to separate the areas of concrete placed at different times, and may be either longitudinal or transverse, as required.

(1) The spacing of longitudinal construction joints will depend largely on the paving equipment. With most present-day equipment, paving lanes 24 feet or more in width are possible and may be used. Determination of the width of paving lane to be used, that is, whether a 24-foot-wide road or street should be paved in a single lane or in two 12-foot-wide lanes, is left to the judgment of the designer.

(2) When a longitudinal construction joint is used at the center of two-lane pavements, a keyed joint with tie bars similar to those required for longitudinal contraction joints, or threaded split 5/8-inch tie bolt, should be used. When a longitudinal construction joint is used at the center of pavements having four or more paving lanes, a doweled joint should be used.

(3) Transverse construction joints should be installed at the end of each day's paving operation, and at other points within a paving lane where the placing of concrete is discontinued a sufficient length of time for the concrete to start to set. All transverse construction joints in nonreinforced rigid pavements should be of the doweled type, and should be located in place of other regularly spaced transverse joints. When paving is resumed, the regular transverse joint construction should be used, beginning with the first regularly scheduled transverse joint. When a transverse construction joint is required within a slab in a reinforced rigid pavement, the reinforcing steel should be carried through the joint and tie bars added.

c. Expansion joints. Expansion joints are provided for the relief of forces resulting from thermal expansion of the pavement, and to permit unrestrained differential horizontal movement of adjoining pavements and/or structures. There are two types of expansion joints, doweled and thickened-edge, both of which should be provided with a nonextruding type filler metal. Usually a preformed filler 3/4-inch thick will be adequate. The expansion joint should be so designed as to provide a complete and uniform separation between the rigid pavements or between the rigid pavement and the structure concerned.

(1) Doweled expansion joints should be used for all transverse expansion joints within rigid pavements except at the intersections of rigid pavements with structures or with other rigid pavements. The

9 Apr 84

designer is cautioned that expansion joints within rigid pavements are difficult to construct and maintain, and often contribute to pavement failures. For these reasons, their use should be kept to the absolute minimum necessary to prevent excessive stresses or distortion in the pavement. Internal expansion joints should be omitted in all rigid pavements 8 inches or more in thickness, and also in pavements less than 8 inches thick when the concrete is placed during warm weather.

(2) At the intersection of two rigid pavements it is necessary to provide for some differential horizontal movement in joints of this type to prevent the expansion of one pavement from distorting the other pavement. In such cases, the transverse expansion joints should be designed as thickened-edge, slip-type joints. Similarly, the thickened-edge, slip-type expansion joint normally will be the most suitable for use where expansion joints are installed to surround or to separate from the pavement any structure that projects through, into, or against the pavement. Typical examples include the approaches to buildings or around drainage inlets.

(3) Should it be necessary to construct a longitudinal expansion joint within a rigid pavement, again a thickened-edge, slip-type expansion joint should be used. Expansion joints are not required between new and existing rigid pavements when the existing pavement is being widened or extended with paving lanes parallel to the longitudinal axis of the existing pavement.

7-2. Joint design. Typical details for the design of expansion, contraction, and construction joints are shown on Standard Mobilization Drawing No. XEC-006 for nonreinforced and reinforced rigid pavements.

a. Doweled joints. The primary function of dowels in rigid pavements is that of a load-transfer device. As such, the dowels effect a reduction in the critical edge stress that is directly proportional to the degree of load transfer achieved at the joint. A secondary function of the dowels is to maintain the vertical alignment of adjacent slabs, thereby preventing faulting at the joint. Dowels should be required for the following types of joints: (a) transverse contraction joints in Class B nonreinforced rigid pavements, (b) transverse contraction joints in all reinforced rigid pavements, (c) transverse construction joints in all nonreinforced rigid pavements, (d) center longitudinal construction joints in rigid pavements four or more lanes in width, and (e) transverse expansion joints in all rigid pavements. Dowel diameter, length, and spacing should be in accordance with the criteria presented in table 7-1. Where dowels larger than 1-inch diameter are required, extra-strength pipe may be used as an alternate for solid bars. When extra-strength steel pipe is used for dowels, however, the pipe should be filled with a stiff mixture of either sand-asphalt or cement mortar, or plugged at the ends of the pipe. If the ends of the pipe are plugged, the plug should fit inside the pipe and be cut off flush with the end of the pipe so that there

9 Apr 84

will be no protruding material to bond with the concrete and prevent free movement of the pavement. Normally, dowels should be located at the middepth of the pavement slab. However, a tolerance of one-half of the dowel diameter, above or below the middepth of the slab, may be allowed in locating the dowels in contraction or construction joints where the allowance of such a tolerance will expedite construction. For doweled expansion joints, the dowels should be placed at the middepth of the slab with no tolerance allowed in positioning the dowels. All dowels should be straight, smooth, and free from burrs at the ends. One-half of each dowel should be painted and oiled or greased thoroughly to prevent bonding with the concrete. Dowels used at expansion joints should be capped at one end to permit unrestrained movement of the dowels when the expansion joints close.

Table 7-1. Doweled Joint Design Requirements

Pavement Thickness (inches)	Less than 8	8 to 11	12 to 15
Dowel Diameter and Type	3/4-inch bar	1-inch bar	1-1/4-inch bar
Maximum Dowel Spacing (inches):			
Expansion Joints	9	10	12
Contraction Joints			
Reinforced Pavement	11	12	14
Nonreinforced Pavement	18	20	24
Construction Joints	12	13	15
Minimum Dowel Length (inches)	15	16	18

b. Keyed joints. As with dowels, keyed joints are constructed to provide load transfer at the joint. The structural adequacy of keyed construction joints in rigid pavements, however, can be impaired seriously by such factors as: (a) small changes in the dimensions of the key, and (b) positioning the key other than at the middepth of the slab. Exceeding the design values for the key dimensions produces an oversize key which can result in failure of either the top or bottom edge of the female side of the joint. Similarly, construction of an undersize key can result in shearing off the key. Keyed joints should not be used in rigid pavements 8 inches or less in thickness except where tie bars are used. Details of the required dimensions for keyed joints are shown on Standard Mobilization Drawing No. XEC-006. It should be noted that the vertical and horizontal dimensions of the key are expressed as a function of the slab thickness. Consequently, the

correct dimensions for the key must be determined for each thickness of pavement. For all thicknesses of pavement where keyed joints may be used, however, the center of the key should be located at the middepth of the slab.

c. Thickened-edge joints. Thickened-edge type joints may be used for all types of expansion joints with the exception of transverse expansion joints within rigid pavements. When thickened-edge joints are used, the amount of increased thickness at the edge should be approximately one-fourth of the design thickness of the main portion of the pavement. The thickening should start at a distance of not less than 3 feet from the joint and taper uniformly to the full required thickness at the joint.

7-3. Joint spacing. For improved pavement performance and lower maintenance costs, it is desirable to keep the number of joints to a minimum by using the maximum joint spacings that will satisfactorily control cracking. Under certain conditions where temperature changes are moderate and high humidity prevails, joint spacings greater than those indicated herein may be satisfactory.

a. Nonreinforced pavements. Transverse contraction joints should be constructed across each paving lane, at intervals not less than 12-1/2 feet nor more than 25 feet. The joint pattern should be made uniform throughout any major paved area. Each joint should be straight and continuous from edge to edge of the paving lane, and extend across all paving lanes for the full width of the paved area. The staggering of joints in adjacent paving lanes should not be permitted. The maximum spacing of transverse joints that will effectively control contraction cracking will vary appreciably depending on pavement thickness, climatic conditions, effective subgrade restraint, coefficients of thermal expansion of the concrete, and other characteristics of the aggregate, cement, etc. The joint spacings shown in the following tabulation have given satisfactory control of contraction cracking in most instances and should be used as a guide subject to modification based on available information regarding local conditions. Experience has shown that under traffic, oblong slabs tend to crack into smaller slabs of nearly equal dimensions. This is particularly true for thin pavements. Therefore, it is desirable to keep the ratio of slab length to width as near unity as practicable. In no case should the slab length exceed the width by more than 25 percent.

<u>Pavement Thickness, inches</u>	<u>Spacing of Contraction Joints, feet</u>
Less than 9	12.5 to 15
9 to 11	15 to 20
More than 11	20 to 25

9 Apr 84

b. Reinforced pavements. Transverse contraction joints in reinforced rigid pavements should be constructed across each paving lane, perpendicular to the pavement centerline, and at intervals of not less than 25 feet nor more than 75 feet. Allowable slab widths or lengths can be determined directly from figure 6-1 for yield strengths of either 56,000 or 60,000 lb/in². Each joint should be straight and continuous from edge to edge of the paving lane and should extend across all paving lanes for the full width of the paved area.

7-4. Joint sealing. All joints in rigid pavements should be sealed with a sealing compound to prevent infiltration of surface water and solid materials into the joint openings. In areas of heavy spillage of diesel fuel or lubricants, a jet-fuel-resistant sealant will be used. In some climates, joint sealing may not be required. Local sources of information, such as state highway departments, should be investigated.